

In Search of Simple, Low-Cost Ventilation

by Steve Loken

We've been building low-energy custom houses in western Montana (7,500 to 9,500 degree-days) for about seven years, and have learned many lessons about ventilation during that time.

Our typical home has an R-19 full basement, R-28 to R-41 above-grade walls, and R-50+ in the ceilings. We use triple or low-e wood-frame windows, and steel or fiberglass insulated doors. For airtightness, we use either a continuous poly air/vapor barrier, or the airtight-drywall method (gaskets or caulk and low-perm paint). Blower-door tests show that our houses are close to airtight—typically, at or below .2 air changes per hour at 50 Pascals.

We have installed heat-recovery ventilators (air-to-air heat exchangers) in many of these houses. These seem to work well when designed and balanced correctly, and we continue to put them in some of the houses.

But it is an uphill battle to find capable installers who understand the intricacies of low-flow duct design. Owner maintenance and control are also a problem. And we find it hard to accept that a system that simply moves a hundred or so cfm of air costs nearly as much to install as a furnace.

In our area, installation costs—labor and materials—range between \$1,400 and \$2,000, depending on the design and complexity of the house. This extra cost has lost us several jobs.

Source Control

The concentration of indoor-air pollution depends upon: 1) the strength of the source; and 2) the rate of removal.

If you don't ventilate a tight building, you are likely to have some type of air-quality problem. But providing mechanical ventilation does not *guarantee* that there won't be a problem. Source strengths of pollutants vary enormously from one building to the next.

Both the public and builders must begin educating themselves about indoor-air quality and pollution sources. Builders can't be expected to build houses that adapt readily to the ventilation requirements of all lifestyles and pollutant sources. Four cigar smokers cooking fish and lounging in a hot tub will have quite different ventilation requirements than an older person who lives alone, showers occasionally, does not smoke, and eats out a lot.

Builders can exercise some control over pollutant sources by carefully selecting construction materials and interior finishes: for example, low-formaldehyde particleboard, and low-emitting solvents, paints, adhesives, glues, and carpets.

But even if a builder could identify, find, and afford a complete package of nontoxic building materials, the occupants would undoubtedly introduce their own pollutants. These pollutants—particle-core furniture, cleansers, hair-spray, oven and furniture sprays, deodorants, foot powder, and cooking techniques—will make the formaldehyde content of underlayment the least of their problems!

Removal

The most common "complaint pol-

lutant" for builders—and the least controllable at the source—is moisture.

Although some indoor moisture sources (firewood drying in the basement or a tropical jungle in the living room) can be eliminated or reduced by the home owner, moisture, for the most part, can be dealt with only by exhausting it to the outside.

Occupants shower, cook, do laundry, and generally add a moisture load to a home's interior. If the house is not adequately ventilated, the moisture will

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show up as condensation on windows, moldy window sash and, in severe cases, structural damage.

Ventilation with No Heat Recovery

About two years ago, we started looking into mechanical-ventilation strategies that would be easy to install, inexpensive, and simple to operate. We began where most conventional builders left off.

Standard practice, for most houses in Montana is a cheap noisy bathroom fan hooked to the bathroom light circuit. In the kitchen, it is usually a powerful and noisy ductless range-hood fan that recirculates cooking grease onto

the forehead of the cook. A few upgrades to this system, we reasoned, could provide adequate ventilation.

We knew that the most effective way to rid a house of moisture is to ventilate it at the "point source"; that is, where it is generated in baths, kitchens, and utility areas. The noise of fans seemed to be the occupants' most frequent complaint, so we searched for exhaust fans that were powerful but quiet enough not to interfere with normal conversation.

A good source of product information on fans is the Home Ventilating Institute (HVI), which is a division of Air Movement and Control Association, Inc., 30 W. University Dr., Arlington Heights, Ill. 60004, 312/394-0150. HVI publishes a useful directory that rates the capacities and noise levels of exhaust fans, and the *HVI Guide*, which offers sizing advice. (See box.)

We began installing fans that had some (noise) ratings of 1.5 to 3 instead of the standard 5 to 7 sones. To protect against infiltration through the ductwork, we found backdraft dampers that would close tightly when the fans were not in use. For exhaust ductwork, we use simple, straightforward four- or five-inch-diameter metal, with fiberglass duct wrap to reduce condensation within the duct.

Here are some of the products we've had luck with: Nutone's QT series and Broan's "Low-Sone" series fans; the inline butterfly damper from Artis Metals (Boise, Idaho); Nutone QT series roof vents and wall vents; the electrically controlled roof damper from Weather Energy Systems (W. Wareham, Mass.).

Controls

We wire the kitchen and bath fans to standard on/off switches and, in series,

to de-humidistat controls. When the humidity exceeds a preset level, one or both fans will automatically switch on.

In a few cases, we've had clients who don't produce much moisture, but smoke a lot of cigarettes. In these cases, we used a "time of day" timer to override both the on/off switch and the de-humidistat. This provided a minimum daily level of ventilation at predetermined times the owner can set. (Some people prefer dumping the ventilation air in the evening after supper; others, in the wee hours of the morning.)

We are currently searching for a solid-state, electronic time-of-day timer, which should be quieter and more convenient than a mechanical timer. W.W. Granger (Chicago, Ill.) offers an electrical timer for under \$30 that we plan to try, but either type of timer will work well.

Tempering Make-Up Air

In a tight house, you need to provide make-up air for an exhaust-only fan. And in cold climates, you need to temper that make-up air to keep the occupants comfortable.

We've tried a couple of techniques. In one, we bring the air in through six-inch-diameter Schedule 40 PVC sewer pipe. This is glued at the joints and laid in next to the footings outside of the basement before backfilling (see diagram). These 50- to 70-foot-long "earth tubes" have brought 60 cfm of outside air from -22°F. up to about 38 degrees. The longer and deeper the tube, the greater the tempering effect.

We slope the tube to a pooling elbow to capture and remove any condensate, should it occur. But, to date, no pooling has taken place, and no noticeable fungus or mildew has shown up. The tubes are a sealed system, so they will not pick

Fan-Sizing Rules of Thumb

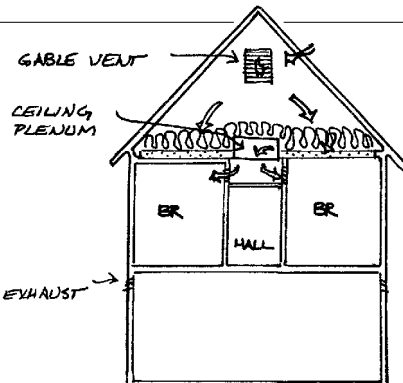
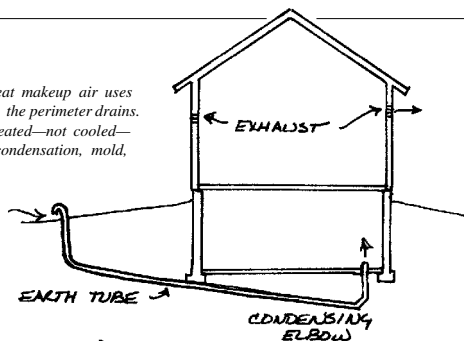
The Home Ventilating Institute suggests the following rules of thumb for minimum fan sizing: To calculate the cubic feet per minute (cfm) capacity of a wall or ceiling fan, multiply the floor area of the room by the appropriate factor (assuming an eight-foot ceiling):

kitchens	2.00
baths	1.07
family/recreation/laundry.....	0.80

These numbers should yield 15 air changes per hour in kitchens, 8 in baths, and 6 in family or rec rooms.

For range hoods along a wall, multiply the length of the hood by 40 to get the cfm of the fan. For peninsular or island hoods, multiply by 50. For example, a 100-square-foot kitchen should have at least a 200 cfm fan. A 2½-foot-long range hood set against a wall should have at least a 100 cfm fan. Remember, these are absolute *minimum* capacities for typically built homes. ■

One system to preheat makeup air uses PVC pipe run next to the perimeter drains. Since air is being heated—not cooled—there should be no condensation, mold, etc., in the tubes.



In this system, makeup air is drawn slowly down through the attic insulation into perforated pipe, then into a plenum. From the plenum it can go directly into bedrooms or into a closet, basement, or other utility space.

up radon or ground moisture.

We have also used attic plenums to preheat incoming air. In this scheme, two to four sections of six-inch perforated PVC pipe are laid in the attic under the insulation. These lead to a 2x2-foot insulated plenum (made from duct board or rigid insulation) and then into the living space.

Other options for tempering make-up air that builders have tried include crawl spaces (in low-radon areas) and sunspaces. Some builders bring tempered air into the house from a sunspace by letting it diffuse through a masonry block wall, which is highly permeable to airflow.

Once the air is inside, we try to find inexpensive ways to distribute it throughout the house. Sometimes we bring the air into a dropped-ceiling area between two bedrooms (see diagram), and then cut registers above the bedroom doorways. The dropped-ceiling plenum permits further mixing and tempering of the make-up air. In other cases, we deliver the make-up air to a closet, utility room, or other space where it will not chill the occupants.

Another alternative is through-the-wall vents, such as those made by American Aides. We have not yet tried these, but they look promising for use in mild climates where untempered make-up air is acceptable.

Cautions

Gas-fired appliances can be dangerous in airtight houses with exhaust-only ventilation systems, due to the risk of backdrafting. The best solution currently is sealed-combustion units for space-and-water heating.

Fireplaces, woodstoves, and other solid-fuel appliances are also a bad idea in tight houses with exhaust-only ventilation, even if combustion air is provided to the firebox. Combustion by-products can still backdraft when the fire burns low and the draft is reduced.

Future Directions

Builders accept innovations that cut costs, are demanded by the marketplace, or are mandated by code. Heat-recovery ventilators, however, are expensive, are seen by many home owners as a nuisance, and are code required in only a few locales. Their market penetration is small, and the majority of the two million housing starts a year are still built to minimum HUD-FHA ventilation standards.

The more modest and less expensive ventilation ideas suggested here may gain acceptance more easily. These approaches—better fans, controls, make-up air strategies—will cost more than standard-practice ventilation (our additional costs have ranged from \$200 to \$350). They are, however, far superior to just recirculating cooking odors and moisture within the house.

The shortcomings of this system, which is basically an upgraded standard-ventilation package, are clear. We may still have pockets of dead, uncirculating air. Indoor pollutants may be so strong that *no* 150- to 300-cfm ventilation system can remove them. And it may be difficult to distribute the tempered air in large houses with many partitions.

For high-end custom houses, HRV's are still available and can be made to work. For many more applications, however, a lower-cost/no-heat-recovery ventilation system is a workable answer.

The challenges are there for manufac-

turers and builders who recognize the problems, and are slowly developing answers for low-cost, safe ventilation systems in low-infiltration houses. There are many possibilities we haven't yet explored. ■

Steve Loken, of South Wall Builders, Missoula, Mont., builds low-energy homes.